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Standard Guide for In-Situ Pipeline Renovation As Dual-Wall Composite Pipeline by Push/Pull Installation of Compressed-Fit Shape-Memory-Polymer Tubular (SMPT)[1]

This standard is issued under the fixed designation F3508; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide describes the specification and reconstruction of in-situ pipelines and conduits 2 in. to 63 in. (50 mm to 1600 mm) diameter) by the pulled-in-place installation, into an existing conduit, of circular, radially reduced, Shape-Memory-Polymer Tubular (SMPT) that after installation, re-expands (by "memory") to press against the ID of the host pipe, thus coupling the interior pipe, by friction fit, as reinforcement to the host pipe. The added SMPT pipe wall restores leak tightness and adds its strength to the host pipe (Dual-Wall Composite-Pipe). It becomes a continuous compressed-fit dual-wall pipeline. Depending upon the SMPT compound used, the re-constructed pipelines or conduits are suitable for pressure and nonpressure pipeline applications such as process piping, raw and treated water transmission, water pipe systems, forced-mains, industrial and oil-patch gathering and transmission pipelines, sanitary sewers, storm sewers, and culverts.

NOTE 1— This standard guide covers circular SMPT tubulars which are radially reduced by mechanical means at the time of installation. This guide does not address "liners" that at the time of manufacture are deformed (folded) into U-shape, C-shape, H-shape, or other such configurations. This guide refers to dual-wall meaning two layers of pipe co-joined in the field, which is different from dual-wall factory-made co-extruded pipe or corrugated pipe. This guide does not provide a complete design basis covering the many variables required for design and construction of this field fabricated product; the advice of professional contractors and/or registered professional engineers may be incorporated as an adjunct to this guide.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

NOTE 2—There are no ISO standards covering the primary subject matter of this guide.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D638 Test Method for Tensile Properties of Plastics
D1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
D1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure
D1599 Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings
D1600 Terminology for Abbreviated Terms Relating to Plastics
D2290 Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic Pipe
D2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
D2513 Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings
D2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
D3035 Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials

[1] This test method is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.67 on Trenchless Plastic Pipeline Technology.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

D4066 Classification System for Nylon Injection and Extrusion Materials (PA)
D4101 Classification System and Basis for Specification for Polypropylene Injection and Extrusion Materials
F412 Terminology Relating to Plastic Piping Systems
F714 Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
F1417 Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air
F1606 Practice for Rehabilitation of Existing Sewers and Conduits with Deformed Polyethylene (PE) Liner
F2164 Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure
F2389 Specification for Pressure-rated Polypropylene (PP) Piping Systems
F2620 Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
F2619/F2619M Specification for High-Density Polyethylene (PE) Line Pipe
F2785 Specification for Polyamide 12 Gas Pressure Pipe, Tubing, and Fittings
F2786 Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Gaseous Testing Media Under Pressure (Pneumatic Leak Testing)
F2945 Specification for Polyamide 11 Gas Pressure Pipe, Tubing, and Fittings
F3183 Practice for Guided Side Bend Evaluation of Polyethylene Pipe Butt Fusion Joint

2.2 *AWWA Standard:*[3]
AWWA C651 Disinfecting Water Mains
AWWA C906 Polyethylene Pressure Pipe and Fittings, 4-in. through 65-in. (110mm – 1650 mm) for Waterworks

2.3 *NSF/ANSI Standards:*[4]
Standard No. 61 for DrinkingWater Systems Components—Health Effects

2.4 *NACE Standards:*[5]
SP0102 Cleaning and Inspection of Pressure Pipelines

2.5 *API Standards:*[6]
API 15LE Specification for Polyethylene Line Pipe

2.6 *Other Standards:*
PPI TR-4 HDB/SDB/PDB/MRS Listed Materials, PPI Listing of Hydrostatic Design Basis (HDB), Strength Design Basis (SDB), Pressure Design Basis (PDB), and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe[7]
APWA Uniform Color Code[8]
NASSCO Recommended Specifications for Sewer Collection System Rehabilitation.[9]
ISO 8501 Preparation Cleaning of Metallic Substrates[10]

3. Terminology

3.1 Thermoplastic definitions are in accordance with Terminology F412, and abbreviations are in accordance with Terminology D1600.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *compressed fit*—the dimensional frictional fit, or interference fit, between the in-situ host pipe and internal SMPT, resulting in a compressive strain between the ID of the host pipe and the OD of the SMPT, resulting in a conjoining held together by friction, forming the composite pipe structure.

3.2.1.1 *Discussion*—The interlaminar stress is mathematically estimated from the measured differential strain, the layer thicknesses, each cylindrical layer's Modulus of Elasticity, Poisson's Ratio.

3.2.2 *composite pipe*—Pipe consisting of two or more different materials arranged with specific functional purpose to serve as pipe. **F412**

3.2.3 *hydrostatic design basis and hydrostatic design stress*—the hydrostatic design stress, HDS, is determined by multiplying the hydrostatic design basis, HDB, by a design factor, DF that has a value less than 1.0.

3.2.3.1 *Discussion*—Refer to Test Method D2837.

3.2.4 *relationship between dimension ratio, hydrostatic design stress, and pressure rating, for thermoplastic tubulars*—

$$P = \frac{2*S}{DR - 1}$$

where:

S = hydrostatic design stress, HDS, for water at 73 °F (23 °C), psi (or kPa or MPa),
P = pressure rating, PR, psi (or kPa or MPa),
DO = outside diameter, in. (or mm),
t = minimum wall thickness, in. (or mm),
$DR = DO/t$ = dimension ratio

3.2.5 *shape memory polymer tubular (SMPT)*—A specified diameter, ductile, plastic pipe extruded from a thermoplastic polymer with a high degree of rubber-like elastic properties (memory reversion characteristics), suitable for temporary radial diameter reduction, such that the mechanical deformation is recoverable back to a very high proportion of the original shape.

3.2.5.1 *Discussion*—Shape memory polymers (SMPs) are polymers which can be deformed into a temporary shape and then return to the original shape, when triggered by an external stimulus. Depending upon the deformation process, the external stimulus may be removal of axial tensile load, imposition of heat internal to the SMPT, application of pressure interior to the SMPT, or a combination there-of.

[3] Available from American Water Works Association (AWWA), 6666 W. Quincy Ave., Denver, CO 80235, http://www.awwa.org.
[4] Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48105, http://www.nsf.org.
[5] Available from NACE International (NACE), 15835 Park Ten Pl., Houston, TX 77084, http://www.nace.org.
[6] Available from American Petroleum Institute (API), 200 Massachusetts Avenue, NW Suite 1100 Washington, DC 20001-5571, http://www.api.org.
[7] Available from Plastics Pipe Institute (PPI), 105 Decker Court, Suite 825, Irving, TX 75062, http://www.plasticpipe.org.
[8] Available from the American Public Works Association (APWA) https://www.apwa.net/
[9] Available from NASSCO 5285 Westview Drive, Suite 202, Frederick, MD 21703 info@nassco.org
[10] Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, https://www.iso.org.